COMPARATIVE TEXTURAL AND MINERALOGICAL STUDIES OF TWO PRIMITIVE ORDINARY CHONDRITES: SARATOV (L4) AND AN UNNAMED (L/LL3) FROM ANTARCTICA. R.K. Herd[1] ,P.A. Hunt[1], K.E. Venance[1] and M.B. Killgore[2], [1]Geological Survey of Canada, Natural Resources Canada, 601 Booth Street, Ottawa, ON K1A 0E8: herd@nrcan.gc.ca , pahunt@nrcan.gc.ca , kvenance@nrcan.gc.ca ; [2]Southwest Meteorite Laboratory, P.O. Box 95, Payson, AZ 85547, U.S.A: meteoritelab@cybertrails.com .

Introduction: Primitive ordinary chondrites potentially contain valuable information about the early Solar System, and are used e.g. in studies of pre-solar grains, the age of chondrule formation, and the age of chondrite equilibration. But documentation of their detailed petrography may be lacking, even though sophisticated chemical and isotopic analyses have been obtained. While documenting and classifying an Antarctic chondrite with low metal and well-defined chondrules [1],[2], we have examined a comparable meteorite, Saratov. Its classification is L4 whereas the other is an L/LL3, probably of grade 3.5 to 3.6 [2]. Saratov fell September 6, 1918, total known weight (TKW) 328 kilograms [3]. To date we have been unsuccessful in discovering a detailed description of its mineralogy and texture although it has been analyzed in some important studies [4],[5],[6], and is widely available in collections and from dealers. Our study adds important information on Saratov. The Antarctic meteorite was found about a decade ago, TKW 2.3 kilograms.

Sample Character: Both meteorites contain an abundance of chondrules, ranging in size from less than a mm. to over a cm. Both are friable, and chondrules are easily detached from samples. Both consist of chondrules and chondrule fragments or agglomerations, matrix, and metal (mainly troilite and FeNi phases) and show a low shock stage (S1- S2) although the L/LL3 may have undergone minor brecciation or even melting. It is moderately weathered.

Polished Thin Section (PTS) Studies:

Methodology: As described previously [2] polished thin sections were systematically documented by colour photomicrographs and mapping in back-scattered electron (BSE) mode with a scanning-electron microscope (SEM). All images were digitized. The mosaic of BSE images, all at the same magnification, were compiled into single large photomosaic maps of the sections. Adjustment of the contrast among adjacent BSE images resulted in virtually seamless maps that show the sections in great detail, and serve to locate areas of investigation at higher magnification. Two polished thin sections of the Antarctic find were available, and one PTS and a thin section of Saratov. The mineralogy and texture of chondrules and matrix were investigated at magnifications up to 1700X. All detailed BSE images were digitized. Energy-dispersive spectrometry (EDS) spot data using the SEM allowed grains of different mineral phases to be distinguished, based on elements present and relative peak heights of each element. The BSE images, annotated as to the qualitative identification of the minerals, were then used to gather quantitative electron-microprobe analyses.

Textural and mineralogical results, L/LL3: The existence of all major ordinary chondrite olivine-pyroxene chondrule types in the L/LL3 chondrite has been reported [2]. They are composed of coarser grained olivine, clinoenstatite and low-Ca orthopyroxene, and Ca-pyroxene, and a mesostasis or matrix partially or completely recrystallized to feldspar, and containing skeletal zoned pyroxenes richer in calcium, iron, aluminum, sodium and chromium. Various accessory phases occur in the chondrules and matrix.

Textural and mineralogical results, Saratov: The BSE mapping and higher magnification SEM study of Saratov L4 reveals that to a first approximation, it contains the same several textural varieties of chondrules as the L/LL3. Many images of chondrule textures are interchangeable from one meteorite to the other. More electron-microprobe analyses of the L/LL3 are planned based on this discovery, and the analyses of Saratov have started in the context of this discovery.

Differences: There are 3 distinct differences noted so far in the study of the L4 as compared to the L/LL3: (1) No relict olivine zonation has yet been detected in Saratov chondrules; it is significant in those of the L/LL3 and clear in SEM photos; (2) The mesostasis of the L4 chondrules is mainly recrystallized to feldspar, mostly calcium-rich plagioclase; in the L/LL3 many mesostases are poorly recrystallized or show transitional textures and mineralogy; (3) Composition of Saratov olivine is recorded as Fa_{24} [5]; we have determined that equilibrated olivine in the L/LL3 is Fa_{26-27} [2].

Interpretation: The lack of zonation in the Saratov olivines means that relatively iron-poor and iron-rich chondrules cannot be identified solely by textural and qualitative study with an SEM equipped with EDS.

Originally iron-poor chondrules, and relict compositional zonation may exist and be revealed by electron-microprobe analyses. The homogeneity of the olivine and the predominance of the recrystallization of the chondrule mesostases to feldspar indicates texturally that equilibration to a higher grade has occurred for Saratov, given the identical textural types of many of the chondrules in each meteorite. If Saratov is classified as L4 based on its olivine composition, apparent lack of olivine zonation, and its chondrule mesostases being mostly recrystallized, then the Antarctic meteorite is confirmed by its textures as being at a slightly lower petrologic grade. Both meteorites contain a few chondrules that appear to be well recrystallized, even though they occur close to others that are less recrystallized. Some higher grade equilibration of some chondrules may have occurred prior to their incorporation into both meteorites.

Conclusion: The size range and similar textural varieties of chondrules in both meteorites, indicate that they are samples of the same chondrule reservoir. They may have had different histories based on isotopic or other analyses not yet available to us. Based on their petrology/petrography, they had similar heating and recrystallization histories. The Saratov fall shows a slightly higher grade than the Antarctic find.

References:

[1] Herd R.K. et al. (2001) *Meteoritics & Planet. Sci., 36,* A79. [2] Herd R.K. et al. (2002) *LPS XXXIII,* Abstract #1957. [3] Grady M. M. (2000) *Catalogue of Meteorites.* [4] Alexander C.M. O'D. et al. (1990) *Earth Planet. Sci. Lett., 99,* 220-229. [5] Rubin A.E. (1990) *Geochim. Cosmochim. Acta, 54,* 1217-1232. [6] Clayton R.N. et al. (1991) *Geochim. Cosmochim. Acta, 55,* 2317-2337.